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С О Д Р Ж И Н А

MATHEMATICAL MODELING AND USING OF THE MATLAB DEVELOPED TOOLS FOR INDUSTRIAL PRODUCTION AND KINETIC FLOTATION MODELLING

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Abstract. To improve kinetic flotation models, many first-order flotation kinetics models with distributions of flotation rate constants were redefined so that they could all be represented by the same set of three model parameters. As a result, the width of the distribution become independent of its mean, and parameters of the model and the curve fitting errors, became virtually the same, independent of the chosen distribution function. In our case, investigations of the chalcopyrite ores are carried out using mathematical modeling and using of the Matlab developed tools for industrial production - Classical model, Klimpel Model and fully mixed model. According to the experimental results obtained in laboratory, the Classical model is most appropriate for presentation of kinetic flotation, especially by means of MATLAB modeling.

Keywords: investigation, modelling, improvement, optimization, mathematical models, Matlab.

1. Introduction

In the existing equations for flotation kinetic the assumption is such that velocity coefficient for any sulphide minerals is the constant k. The number of investigators, as A. Gupta, D.S. Juan had calculated the of group models cumulative flotation from first order considering the following models:

- Classical kinetic model, $I=I_o[1-e^{-kt}]$
- Klimpel kinetic model, $I=I_o[1-\frac{1}{kt}(1-e^{-kt})]$
- Kelsal kinetic model, $I = (i_o-\phi)(1-e^{-kft})+ (1-e^{-kst})$
- Modified Kelsal kinetic model – Gama model from Loveday, Innou, $I=I_o(1-(\frac{k}{k+t})^P)$

The mentioned kinetic models are appropriate for presentation *the flotation kinetic*, very important for everyone project solution or assumption for good and sure flotation performance. According to the previous kinetic investigations for kinetic flotation (Classical kinetic model) for different sulphide, minerals for copper mineral will have the following equation (chalcopyrite):

$$I = I_o[1-e^{-kt}] = 89.25\ [1 - e^{-1.025xt}]$$

According to previous kinetic investigations for kinetic flotation (Classical kinetic model) for different oxide - sulphide minerals constant k for copper mineral will have the following equation (65% chalcopyrite and 35% oxide minerals as cuprite, azurite, and malachite):

$$I = I_o[1-e^{-kt}] = 73.5\ [1 - e^{-0.56xt}]$$

According to the existing kinetic investigations for kinetic flotation (Classical kinetic model) for different oxide - sulphide minerals constant k for copper mineral will have the following equation (65% chalcopyrite and 35% oxide minerals as cuprite, azurite, malachite), but with application of process of sulphidization with Na_2S, $(NH_4)_2SO_4$, NH_2SO_4 :

$$I = I_o[1-e^{-kt}] = 74.2\ [1 - e^{-0.61xt}]$$

2. Kinetic flotation modeling of chalcopyrite using software tools

The software package for kinetic flotation modeling in MATLAB®(R) GUI, was enabling appropriate tabular or graphic presentation for Classical kinetic model (I. Brezani, F. Zelenek), determining the constant k in the function of the time frequency of the useful reagent addition.

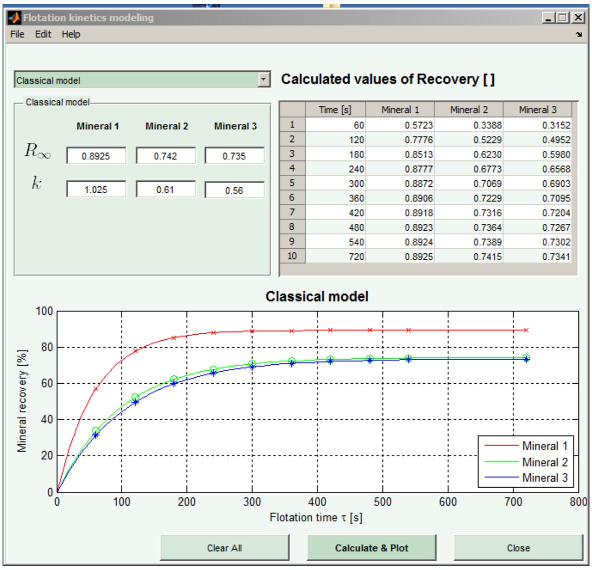


Figure 1. Kinetic presentation by Matlab – Classical model

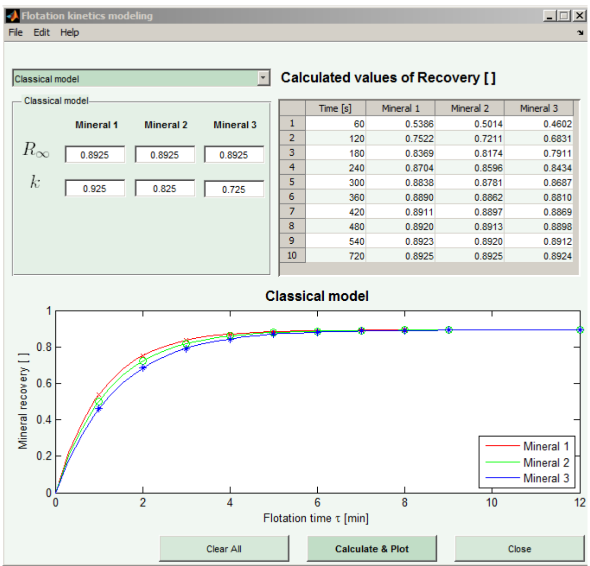


Figure 2. . Kinetic presentation by Matlab– Classical model

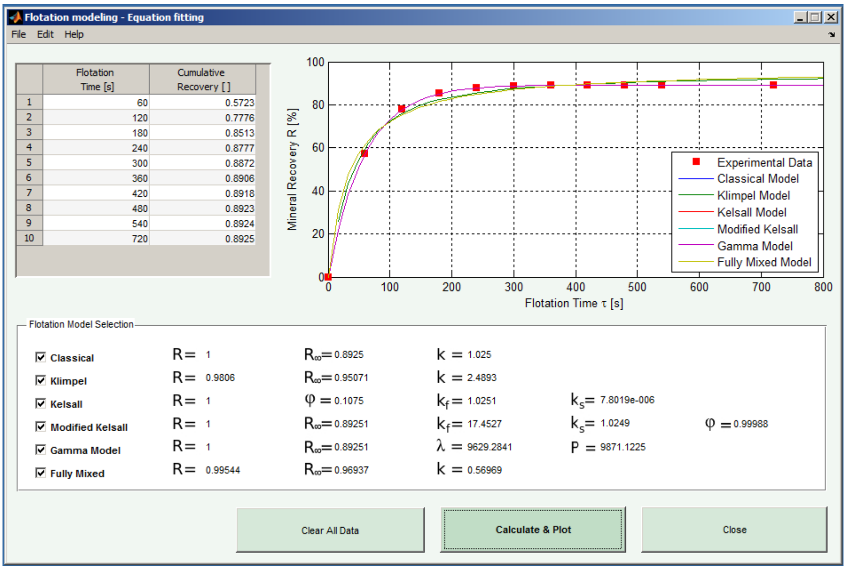
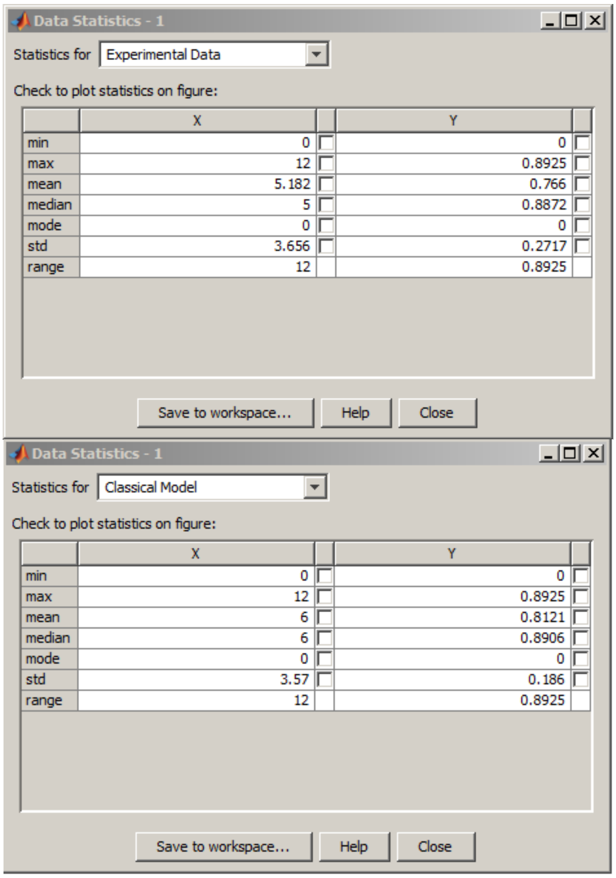


Figure 3. Kinetic presentation by Matlab



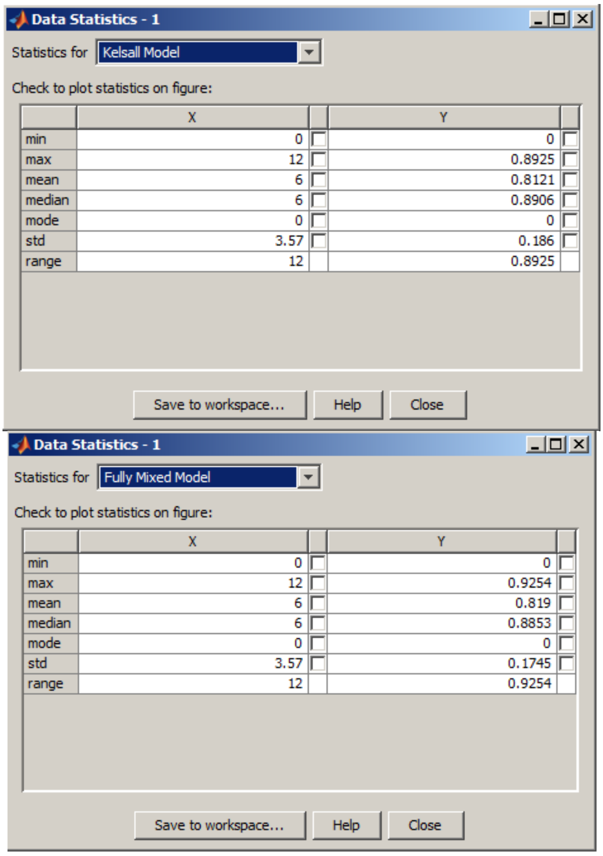


Figure 4. Results in total – comparison for all models

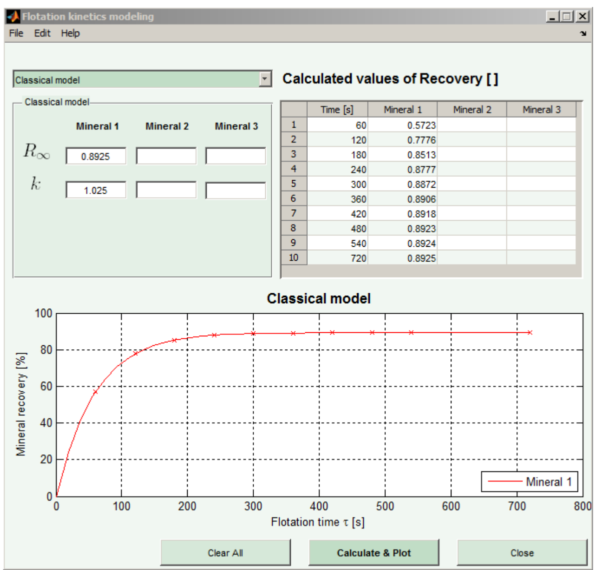


Figure 5. Kinetic presentation by Matlab

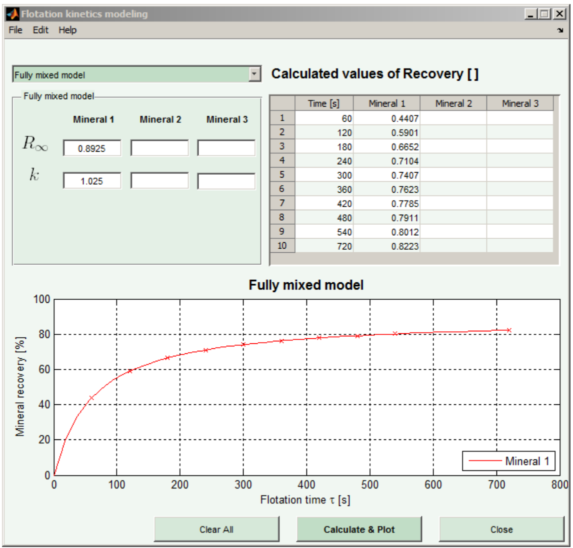


Figure 6. Kinetic presentation by Matlab

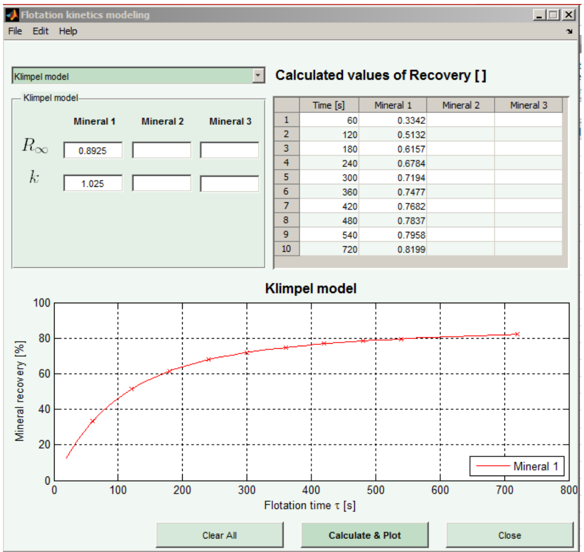


Figure 7. Kinetic presentation by Matlab

Table 1. Comparison of models

(I)	*Classical model*	*Klimpel model*	*Fully mixed model*	*Experimental results (Mine)*
Time (s)	*Mineral*	*Mineral*	*Mineral*	*Mineral*
60	0.5723	0.3342	0.4407	0.5706
120	0.7776	0.5132	0.5901	0.7711
180	0.8513	0.6157	0.6652	0.8383
240	0.8777	0.6784	0.7104	0.8623
300	0.8872	0.7194	0.7407	0.8793
360	0.8906	0.7477	0.7623	0.8860
420	0.8918	0.7682	0.7785	0.8890
480	0.8923	0.7837	0.7911	0.8897
540	0.8924	0.7958	0.8012	0.8903
720	0.8925	0.8199	0.8223	0.8925

Table 2. Comparation of standard deviation for Classical model and fully mixed model

Classical model	*Fully mixed model*		ΔI	ΔI²	ΔI ²/ 9
57.23	44.07		13.16	173.18	
77.76	59.01		18.75	351.56	
85.13	66.52		18.61	346.33	
87.77	71.04		16.73	279.89	
88.72	74.07		14.65	214.62	
89.06	76.23		12.83	164.60	
89.18	77.85		11.33	128.39	
89.23	79.11		10.12	102.41	
89.24	80.12		9.12	83.17	
89.25	82.23		7.02	49.28	
				ΣΔI²=1.893.43 $\sqrt{\frac{\Sigma \Delta I^2}{9}} = 14.50$	

Table 3. Comparation of standard deviation for Classical model and Experimental results

Classical model	*Experimental results*		ΔI	ΔI^2	$\Delta I^2/9$
57.23	57.06		0.17	0.0289	
77.76	77.11		0.65	0.4225	
85.13	83.83		1.30	1.6900	
87.77	86.23		1.54	2.3716	
88.72	87.93		0.79	0.6241	
89.06	88.60		0.46	0.2116	
89.18	88.90		0.28	0.0784	
89.23	88.97		0.26	0.0676	
89.24	89.03		0.21	0.0441	
89.25	89.25		0.00	0.0000	
				$\Sigma\Delta I^2=5.5388$ $\sqrt{\frac{\sum \Delta I^2}{9}} = 0.784$	

After comparing models Classical, Klimpel and Fully mixed model with our experimental results, we concluded that the utilization (%) of copper concentrate, the most appropriate model for the regime of flotating for mine is a classic model - Classical model.

CONCLUSION

According to the experimental results obtained in laboratory and industrial conditions, the Classical model is most appropriate for presentation of kinetic flotation, especially by means of MATLAB modeling.

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